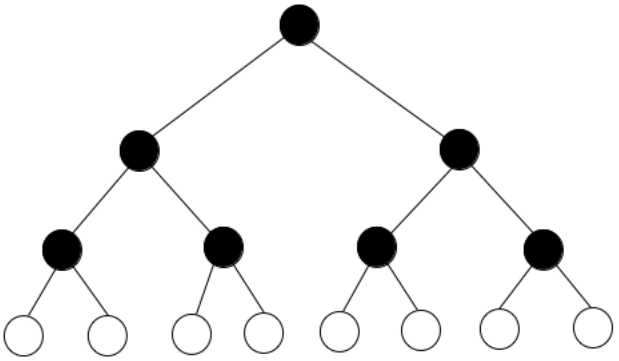
Binary Continued!
Meeting 3

4/22/12

Binary Tree



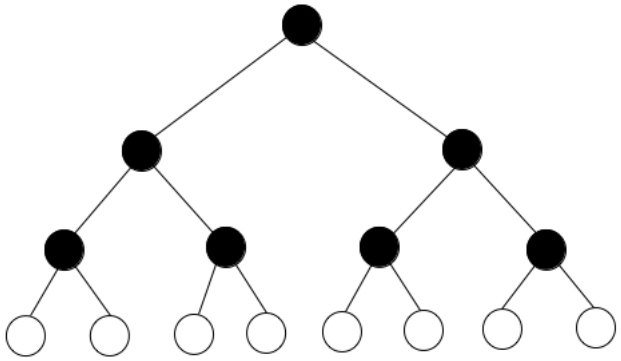
1. Label the vertices of bottom row by numbers 0 through 7 (going from left to right). (You may put numbers right inside of the circles).

2. Play the game "Guess my number" (with numbers from 0 to 7). The goal is to be able to guess the number from 3 attempts (or less, if you are lucky). Can you think of how the edges can help you to formulate the strategy? What is the best way to play the game?

3. Label all the edges pointing to the left by 0;

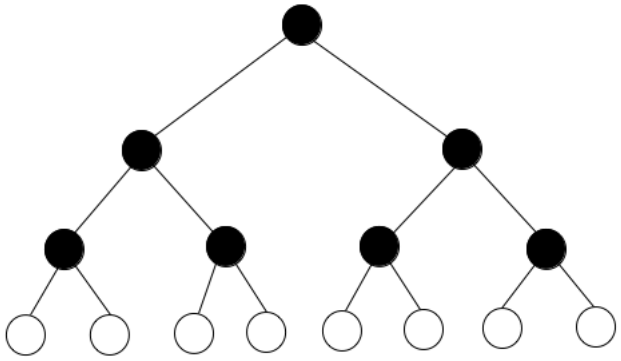
   Label all the edges pointing to the right by 1.

4. For each number on the bottom, there is exactly one path (route) from the top circle down to this number.



- Mark the path from the top circle to the number 3;
- Mark with a different color the path from the top circle to the number 6;

5. For each number, the path connecting the top circle with this number gives you a string of 0s and 1s.



(a) Going from top to bottom, write down the string of 0s and 1s along the path going from the top circle to the number 2.

(b) Write down the string of 0s and 1s along the path from the top circle to the number 6.

(c) Do you recognize your answers in (a) and (b)? (You can ignore the 0s in the beginning of the string). What do these answers represent?

6. How many questions do you have to ask to guess the number in the "Guess my number" game with numbers ranging

(a) from 0 through 7?

(b) from 0 through 15?

(c) from 0 through 31?

A card trick

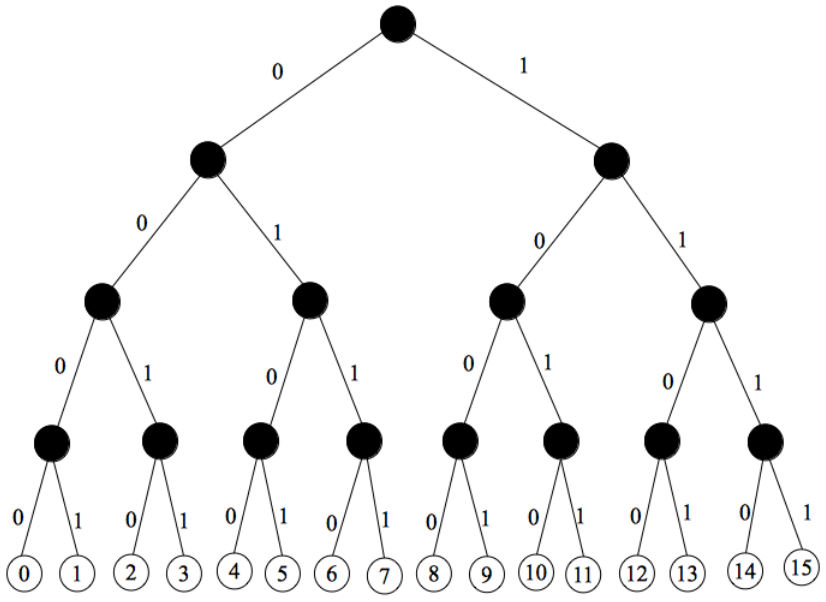
I have 4 cards with numbers 1 through 15 written on them. (Note that most of the numbers appear on several cards). Here are the cards:

$$\begin{pmatrix} 8 & 9 & 10 & 11 \\ 12 & 13 & 14 & 15 \end{pmatrix} \quad \begin{pmatrix} 4 & 5 & 6 & 7 \\ 12 & 13 & 14 & 15 \end{pmatrix} \quad \begin{pmatrix} 2 & 3 & 6 & 7 \\ 10 & 11 & 14 & 15 \end{pmatrix} \quad \begin{pmatrix} 1 & 3 & 5 & 7 \\ 9 & 11 & 13 & 15 \end{pmatrix}$$

All these numbers can be written in binary notation using 4 digits (for some numbers, the first digit(s) can be 0s).

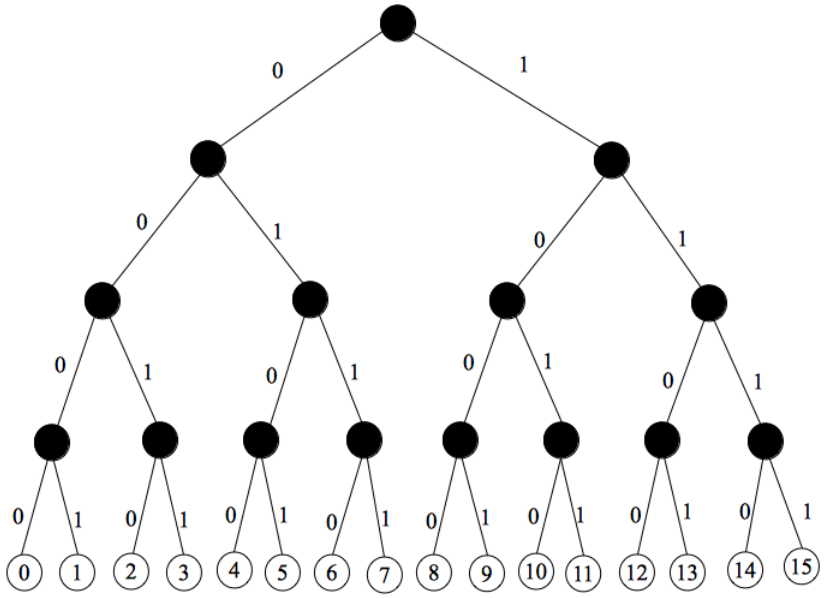
1. List all the numbers that appear only on one card. Do you recognize them?

2. On the binary tree below mark the numbers appearing on Card 1. What do they have in common? (Look at the edges)



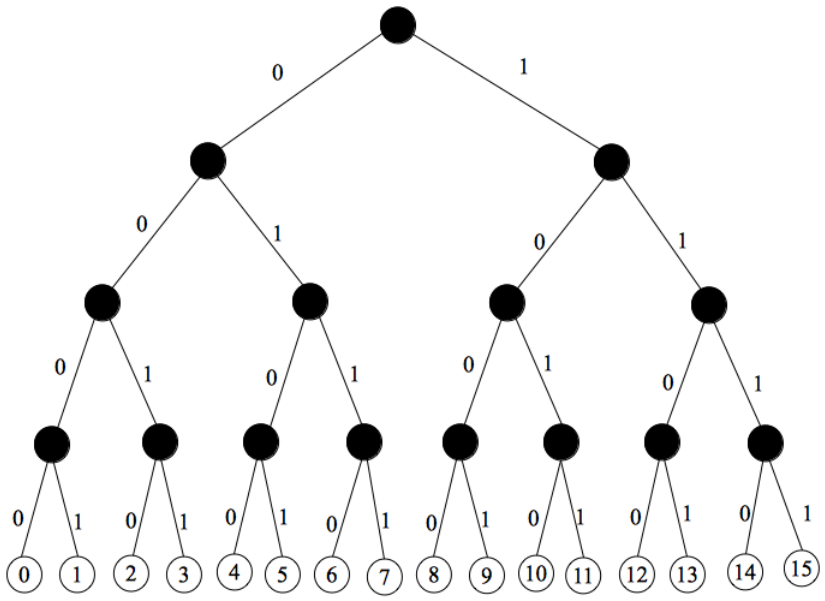
3. What is the first binary digit of all the numbers appearing on Card 1?

4. On the binary tree below mark the numbers appearing on Card 2. What do they have in common?



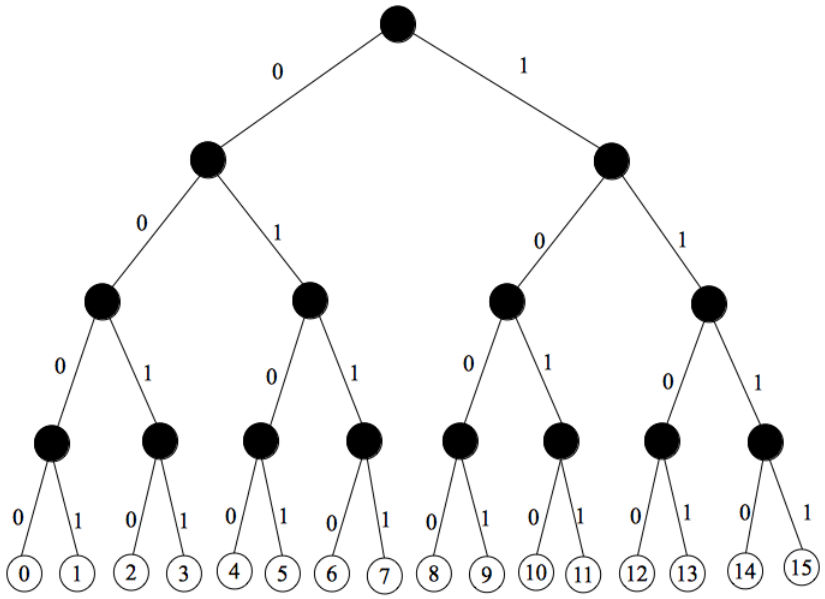
5. What is the second digit of all the numbers appearing on Card 2?

6. On the binary tree below mark the numbers appearing on Card 3. What do they have in common?



7. What is the third binary digit of all numbers appearing on Card 3?

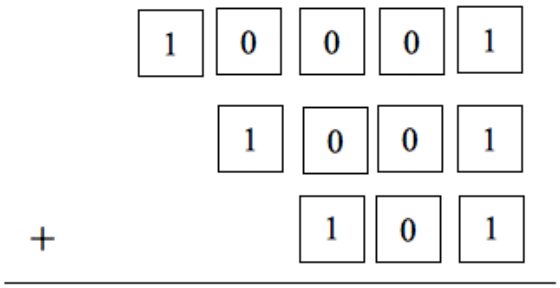
8. On the binary tree below mark the numbers appearing on Card 4. What do they have in common?



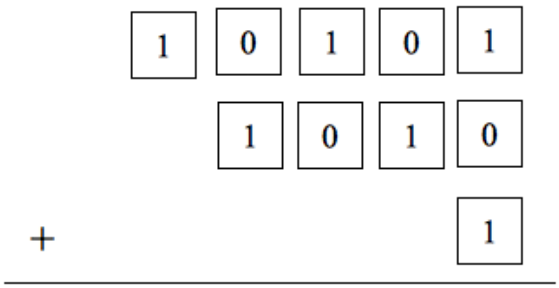
9. What is the last binary digit of all numbers appearing on Card 4?

10. How can you tell what number you have given the numbers of the cards it is written on?

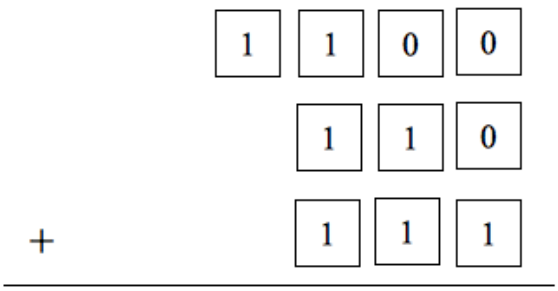
11. **Adding and Subtracting Continued!**
Solve the following addition and subtraction problems. Remember to box your digits.



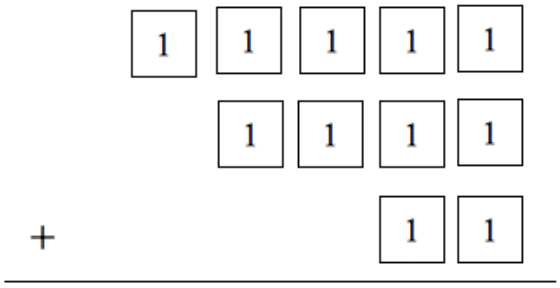
(a)



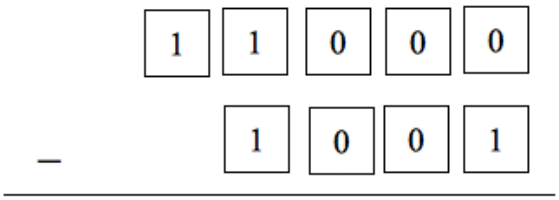
(b)



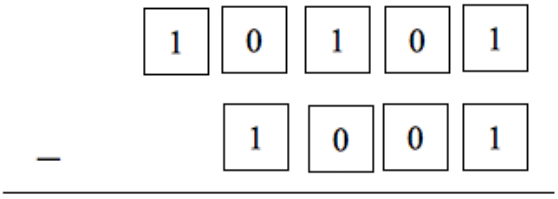
(c)



(d)



(e)



(f)

12. **Counting Binary Numbers with your Fingers!**
Last week, we learned to count to 31 with your fingers of your left hand. For the pictures of different hand positions below, write down the numbers they represent in binary notation and decimal notation.

Remember that the pinky finger is the highest digit (16) and the thumb is the lowest digit (1).

(a) 

(b) 

(c) 

(d) 

(e) 

13. **Homework!**

(a) Make cards for the card trick game that we played earlier today with the numbers 1-7.

How many cards will you need? (Hint: Think about the number of binary digits needed to write 7.)

(b) Go back to the addition and subtraction problems from today's lesson and convert the problem and your answers to decimal notation. Does your answer make sense?